Histol Histopath (1991) 6: 229-233

Histology and Histopathology

# Ultrastructural study of bronchial epithelium in chronic respiratory diseases

**K. Kaidoglou, V. Aivazis, A. Alvanou, G. Saricos, Chr. Tzimakas and Chr. Foroglou**

Laboratory of Histology-Embryology, Aristotelian University of Thessaloniki and University Unit of Bronchoscopy, General Hospital «Georgios Papanicolaou», Thessaloniki, Greece

**Summary.** The fine structure of bronchial epithelium in thirty-six patients, thirty-one men and five women, suffering from chronic obstructive pneumonopathy or bronchial carcinoma was studied. No remarkable alterations were found with electron microscopy, in most non-smokers in contrast to the smokers who presented destruction of the epithelial cells and loss of the cilia or many pathological cilia with an abnormal microtubular configuration and irregular orientation.

The severity, however, of the alterations was not related to the severity of smoking and to the presence of bronchial cancer.

**Key words:** Ultrastructure, Respiratory diseases, Bronchial epithelium

## Introduction

Normal ciliary function is a primary defence mechanism of the respiratory tract and is related to ciliary ultrastructure.

The ciliary microstructural abnormalities, which cause the dysfunction of the respiratory epithelium, have been recognized recently by many investigators as a main etiopathogenetic factor of chronic respiratory diseases and possibly some neoplasms (Alsby and Ghadially, 1973; Howell et al., 1980; Takasaka et al., 1980).

The fine structure of bronchial epithelium in patients suffering from chronic respiratory diseases was studied with transmission electron microscopy. The aim of the present investigation was to reveal alterations which cause pathological phenomena in the respiratory tract under the influence of endogenous or exogenous factors.

*Offprint requests to:* Dr. K. Kaidoglou, Laboratory of Histology and Embryology, Medical Faculty, University of Thessaloniki, Thessaloniki, Greece

## Materials and methods

36 adults, 31 men and 5 women, between the ages of 31 and 77 years were studied. Twenty-eight of these patients had chronic obstructive pneumonopathy and the other eight, all male smokers, had bronchial carcinoma.

The patients were divided, according to their age, into two groups, $< 50$ and $> 50$ years old, and according to them being smokers or non-smokers.

Biopsies were obtained from carina with the flexible bronchoscope and the mucosa pieces were fixed in 3% glutaraldehyde in phosphate buffer pH 7.3 for 2 hours and then were postfixed in 2% osmium tetroxide. After staining with 1% aqueous solution of uranyl acetate, the tissue pieces were dehydrated in a series of alcohol solutions and then embedded in EPON. Thin sections were stained with lead citrate and were observed in a Jeol 100 CX TEM at 80 KV.

## Results

Most non-smokers did not show remarkable alterations of ciliated epithelium in contrast to the smokers' group in which the biopsies of bronchial mucosa showed abnormal epithelial organization and many cilia with a variety of ultrastructural defects.

In 10 patients of the smokers' group, the epithelial cells were destroyed or had vacuoles and many mucous secretory granules in their cytoplasm. On the luminal borders, cilia were missing (Fig. 1).

In some cases the epithelial cell cytoplasm was packed with mitochondria. In 18 patients, 7 non-smokers and 11 smokers, the bronchial epithelium was normal in appearance with ciliated and mucous cells. However cross sections of many axonemes, at high magnifications, revealed structural alterations, i.e. 7+2, 9+3, 8+2, microtubular configuration, eccentric position of central tubule complex, abnormal arrangement of outer microtubular doublets and single or supernumerary

**Table 1.**

| Age of patients | < 50 yrs | > 50 yrs |
|---|---|---|
| N° of patients | 7 | 29 |

**Table 2.**

| | Smoking habbit | | | | |
|---|---|---|---|---|---|
| | Smokers | | | | No smokers |
| Cigarettes/ day | 10-20 | 21-30 | 31-40 | > 40 | |
| No of patients | 5 | 11 | 9 | 3 | 8 |

microtubules (Fig. 2). The orientation of the central pairs in adjacent cilia was irregular (Fig. 3).

Compound cilia were present in 13 patients of the smokers' group (Fig. 4). Finally, in 3 cases of the same group the ultrastructure of many axonemes showed lack of radial spokes (Fig. 5).

## Discussion

The histological findings of our study support the view that the dysfunction of the respiratory tract cilia is related to a variety of ultrastructural defects. In previous studies by Afzelius (1976), Eliasson et al. (1977), Sturgess et al. (1979, 1980), Antonelli et al. (1981), the structural abnormality associated with congenital pathological conditions, such as Kartagener's and immotile cilia syndrome was defined. Also, Howell et al. (1980) and Takasaka et al. (1980) have intimated an increase incidence of ciliary defects associated with chronic respiratory infections and possibly some neoplasms.

Acquired, non-specific, transient and reversible structural abnormalities of epithelium, including dilatation of endoplasmic reticulum membranes, vacuoles in cytoplasm, condensation of the mitochondrial matrix, progressive loss of ciliated cells and abnormal microtubular configuration were observed by Carson et al. (1985) in the acute phase of viral respiratory infections. In our study, the epithelial cell abnormalities and the complete loss of the cilia were the main findings in about 1/3 of the patients. All deviations from the 9+2 configuration of the microtubular complex, the disorientation of the central pair and the

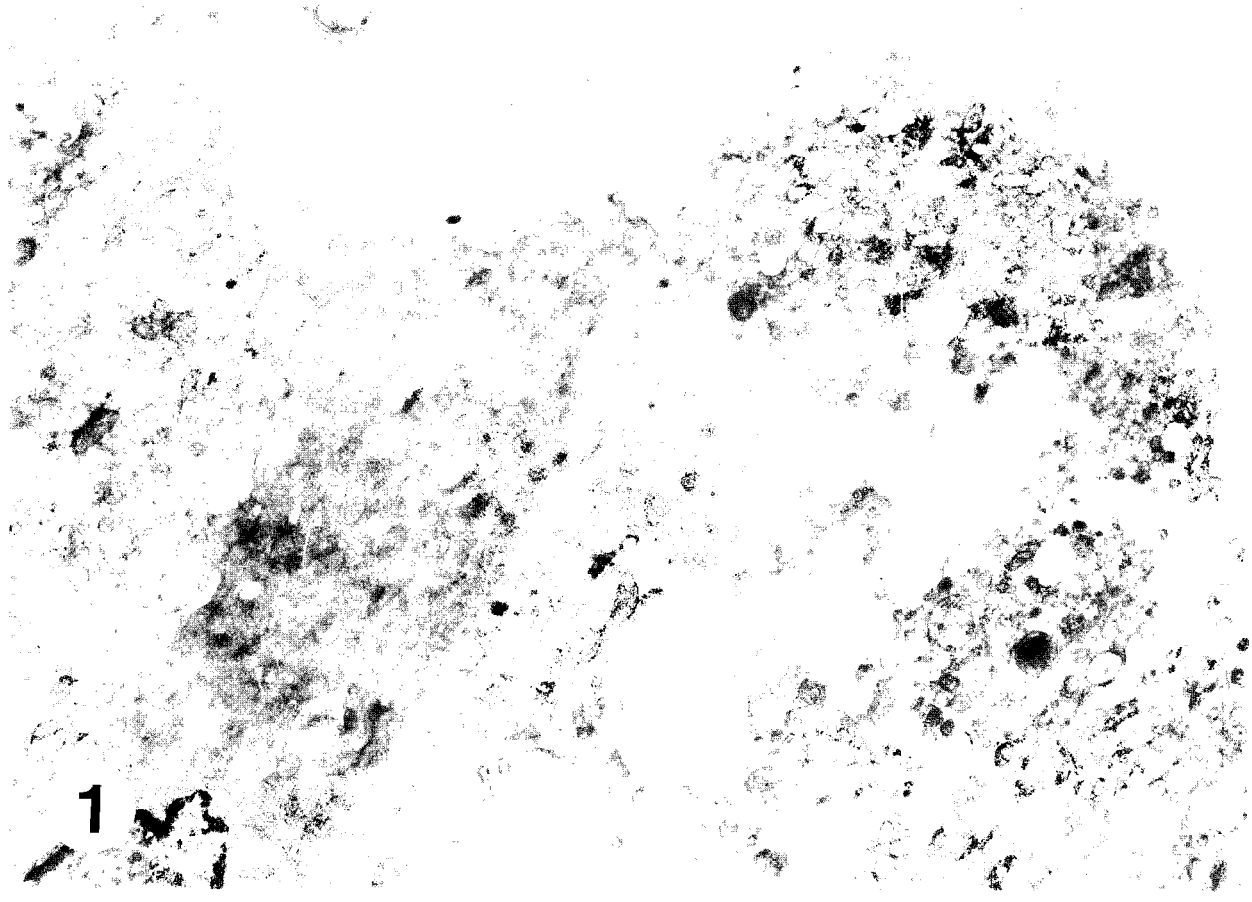


**Fig. 1.** Electron micrograph from bronchial epithelium of patient. Abnormal ciliated cell can be seen. Notice the complete loss of the cilia on the luminal border. × 10,000

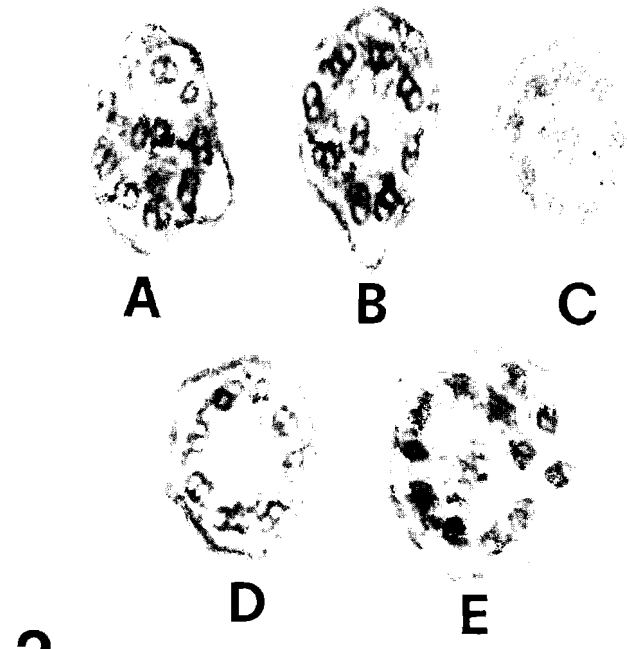


**Fig. 2.** Cilia with abnormal microtubular patterns. A = single outer microtubule. B=8 + 2 configuration, C = addition to the central microtubular pair, D = the central microtubules are lacking, E = supernumerary microtubules in the central region of the axoneme. A × 125,000. B × 125,000. C × 100,000 D × 110,000. E × 106,000

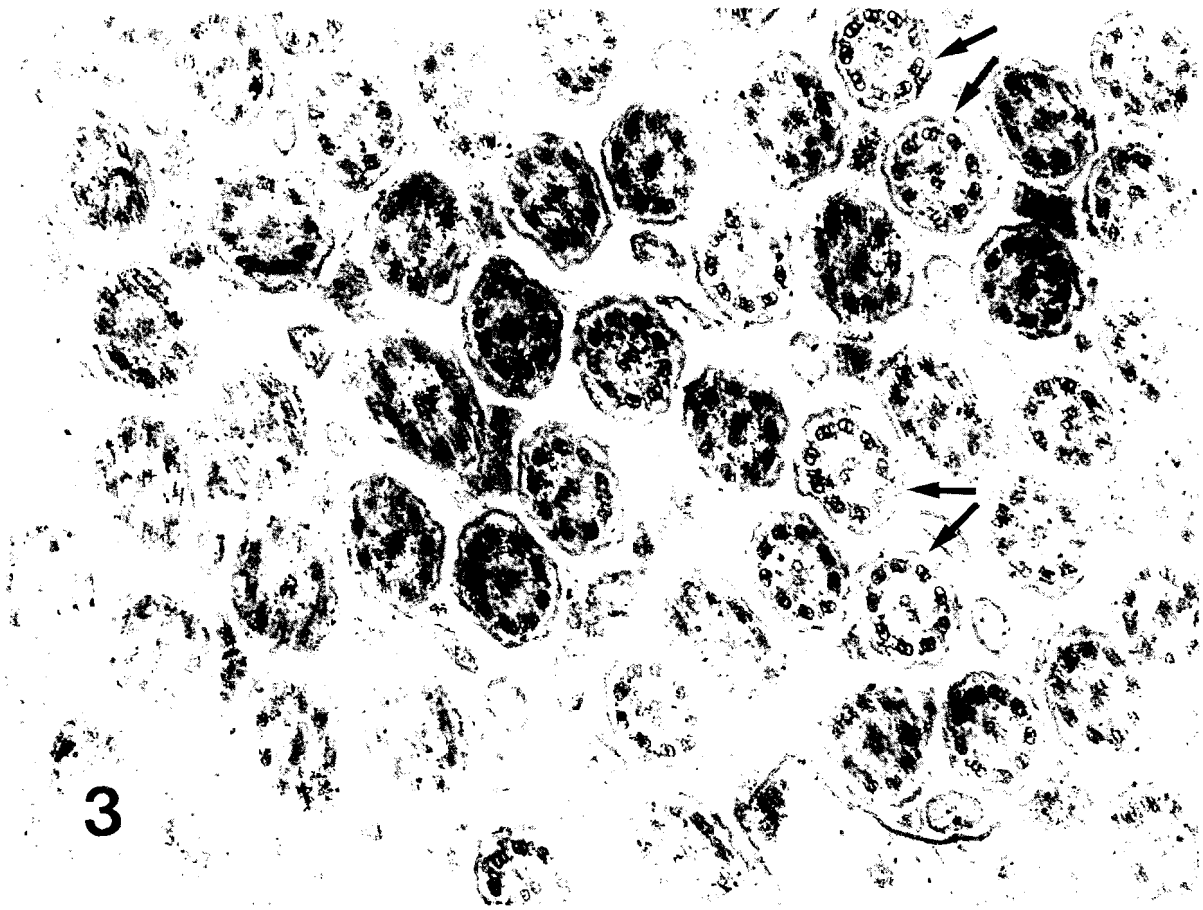


**Fig. 3.** Cilia with irregular orientation. The central pairs of microtubules of adjacent cilia are not in proper parallel alignment (arrows). × 60,000

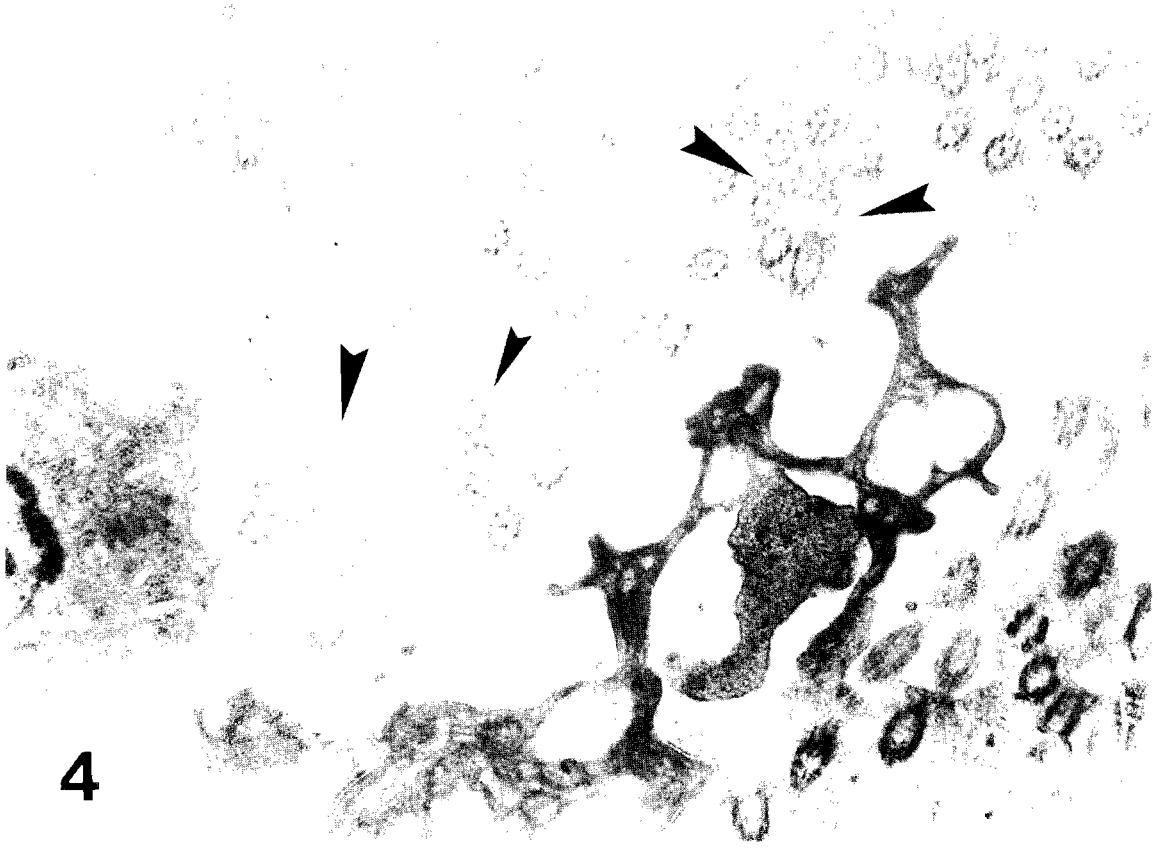


**Fig. 4.** Surface of bronchial epithelium. Note compund cilia. × 22,400

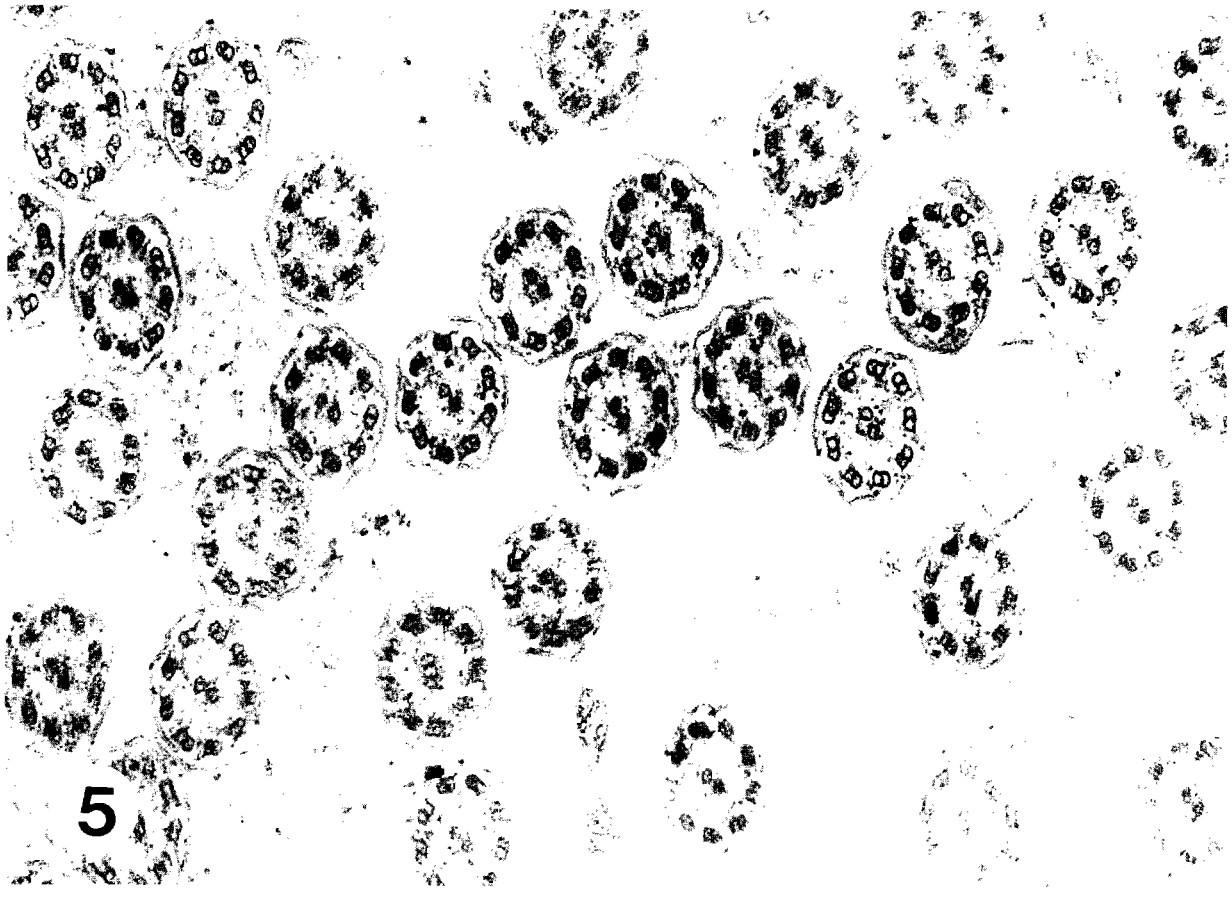


**Fig. 5.** Cross sections through cilia. Radial spokes of the axonemes cannot be distinguished. × 70,000

deficiency of dynein arms and radial spokes, are the most frequent axoneme structural anomalies that contribute to immotile cilia syndrome etiopathogeny. These ciliary abnormalities are congenital, as suggested by Carson et al. (1985) and Ramet et al. (1986), and not epiphenomena secondary to infections or other lesions of respiratory mucosa. Compound cilia, a characteristic finding in 13 patients of the smokers group, is a pathological complex, observed in patients with chronic respiratory diseases and also in some tumours and in heavy smokers (Ghadially, 1975).

The results of this study showed no remarkable alterations of ciliated epithelium in most non-smokers in contrast to smokers, who presented destruction of the epithelial cells and many pathological cilia.

However the severity of alterations was not related to the severity of smoking and to the presence of bronchial cancer. Finally, it is noteworthy that the more serious lesions were localized in the bronchial epithelium of older patients.

## References

Afzelius B.A. (1976). Human syndrome caused by immotile cilia. Science 193, 317-319.

Alsby R.L. and Ghadially F.N. (1973). Atypical cilia in human bronchial mucosa. J. Pathol. 109, 75.

Antonelli M., Modesti A., de Angelis M., Marcolini P., Lucarelli N. and Crifo S. (1981). Immotile cilia syndrome: radial spokes deficiency in a patient with Kartagener's triad. Acta Paediatr. Scand. 70, 571-573.

Carson J.L., Collier A.M. and Shin-Chin S.Hu. (1985). Acquired ciliary defects in nasal epithelium of children with acute viral upper respiratory infections. N. Engl. J. Med. 312, 463-468.

Eliasson R., Mossberg B., Camner P. and Afzelius B.A. (1977). The immotile cilia syndrome. N. Engl. J. Med. 297, 1-6.

Ghadially F.N. (1975). Ultrastructural pathology of the cell. 3th ed. London. Butterworths, 520.

Howell I.T., Schochet S.S. and Goldman A.S. (1980). Ultrastructural defects of respiratory tract cilia associated with chronic infections. Arch. Pathol. Lab. Med. 104, 52-55.

Ramet J., Byloos J., Delree M., Sacre L. and Clement P. (1986). Neonatal diagnosis of the immotile cilia syndrome. Chet 90, 138-139.

Sturgess J.M., Chao J., Wong J., Aspin N. and Turner P. (1979). Chest Cilia with defective radial spokes. N. Engl. J. Med. 300, 53-56.

Sturgess J.M., Chao J. and Turner P. (1980). Transposition of ciliary microtubules: another cause of impaired ciliary motility. N. Engl. J. Med. 303, 318-322.

Takasaka T., Sato M. and Onodera A. (1980). Atypical cilia of the human nasal mucosa. Ann. Otol. Rhinol. Laryngol. 89, 37-45.

Accepted November 25, 1990